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SPECIAL REPORT 92-002

A PERFORMANCE ASSESSMENT TASK FOR EXAMINING TACTICAL DECISION MAKING UNDER STRESS

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EXECUTIVE SUMMARY

PROBLEM

The military's current focus on Crisis And Limited Objective Warfare (CALOW) environments demands that operational personnel be prepared to rapidly process and synthesize large amounts of dynamic data in order to meet threats on potentially short notice. However, when the amount of data that must be processed exceeds an individual's information processing capacity, decision making performance may falter.

PURPOSE

To address this problem, the Office of Naval Technology (ONT) initiated a program of research known as TActical Decision Making Under Stress (TADMUS). The intent of the program is to develop principles, guidelines, and instructional strategies geared toward reducing performance decrements in stressful environments. This report describes one component of the TADMUS effort which involved the development of a performance assessment task for researching tactical decision making performance in the laboratory. That task is the TActical Navy DEcision Making System (TANDEMS).

APPROACH

Based on extensive interviews and observations of actual Combat Information Centers (CICs), a subset of functions was selected for simulation. The selection process was guided by several factors: eventual experimental needs, realism, cognitive requirements, and representativeness. Functions characteristic of CIC environments vary across platforms and mission areas; however, all surface combatants operate under a "doctrine" which mandates that certain functions be performed regardless of platform type. These functions include detection, tracking, identification, action, and battle damage assessment. Three of these functions - detection, identification, and action - were selected as representative samples of the types of tasks performed within all CICs and were incorporated within TANDEMS.

SYSTEM DESCRIPTION

TANDEMS was designed and developed by the Naval Training Systems Center and runs on an IBM-compatible personal computer. Users view a "radar" display on the left side of the PC monitor. Located on this display are radar contacts of unknown type and classification. On the right side of the monitor are several menus that the user may access by manipulating a trackball. Accessing and reviewing information within these menus allows the user to determine each radar contact's type (aircraft, surface ship, or submarine) as well as its

classification (friendly or hostile). By reviewing the information in the menus, the user will be in a position to identify and act upon each contact by labeling it and then performing a final engagement. The system provides the user with performance feedback and also automatically records performance for subsequent data analysis.

RECOMMENDED USES

TANDEMS is a useful laboratory tool for assessing decision making performance in the presence of various stressors. Stressors related to the TANDEMS task (task-related stressors), as well as stressors peripheral to the TANDEMS task (ambient stressors) can be superimposed during TANDEMS use in order to examine their impact on performance. Questions concerning how and when stressors impact performance, differential effects of task-related and ambient stressors, compound versus individual stressor impacts, and stressor-exposure during skill acquisition can all be examined within the TANDEMS test bed.

CONCLUSIONS

TANDEMS provides a tool for examining the performance impact of CIC-like stress. The similarity of cognitive demands and information processing requirements between operational CICs and the TANDEMS test facility makes TANDEMS a useful research task within this domain. Research from the TANDEMS test bed is expected to provide insights into techniques for minimizing performance decrements in stressful environments. The TANDEMS facility allows the examination of several critical questions about decision making under stress.

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INTRODUCTION

PROBLEM

As modern weapon systems push the technology envelope and military focus shifts toward the crisis and limited objective warfare (CALOW) environment, team members are often placed in precarious positions requiring the rapid processing and synthesis of vast amounts of data before decisions can be reached (Coovert, Cannon-Bowers, & Salas, 1990; Driskell & Salas, 1991a, 1991b). When the amount of data that must be processed exceeds the information processing capacity of the individual, performance breaks down. In addition to the technological sophistication of equipment and demanding CALOW situations, the stress resulting from factors such as time compression, information ambiguity, fatigue, and command pressure may contribute to inaccurate data assessment, erroneous conclusions, and slow or faulty decisions - all of which can lead to disastrous consequences in the operational environment (Cannon-Bowers & Salas, 1990; Cannon-Bowers, Salas, & Grossman, 1991).

In an attempt to minimize performance degradation in stressful environments, the Office of Naval Technology (ONT) initiated the TActical Decision Making Under Stress (TADMUS) program. The ultimate goal of this effort is to develop principles and strategies for both training and decision support systems which will maximize performance in such environments. While the TADMUS program is a multi-year, protracted effort, one element of this program involves the establishment of an experimental test facility to conduct a systematic series of experiments designed to examine individual and team performance under stress. While high fidelity facilities may be essential for understanding complex operational team processes, there is a need to have theoretically-based, operationally-relevant tasks that allow better experimental control within the laboratory context. A review of the literature showed that no testbed facilities existed which would provide the type of tasks relevant to the environment we desired. What was needed was a facility which provided a level of versatility in terms of continuous availability, rapid scenario creation, automated performance measurement, experimental control, and tasks representative of those occurring in Combat Information Centers (CIC). Consequently, the TActical Naval DEcision Making System (TANDEMS) was developed to meet these needs.

PURPOSE

The purpose of this report is to describe TANDEMS, document its development, and describe several research opportunities that will be pursued using TANDEMS.

SCOPE

Although TANDEMS is designed to be used in either a team or individual user mode, this report describes the system only from the individual user perspective. The team mode, while very similar to the individual mode, will be addressed in a separate report.

ORGANIZATION OF THE REPORT

Following this introduction, this report describes the approach taken in developing TANDEMS, provides a system description, addresses research opportunities, and presents conclusions.

APPROACH

THEORETICAL BASIS

Most of the theoretical explanations of human information processing rest upon the fundamental notion of a finite attentional resource pool (Cohen, 1978; Fisk & Schneider, 1981; Glass & Singer, 1972; Kahneman, 1973; Kanfer & Ackerman, 1989; Shiffrin & Schneider, 1977). Provided that the quantity of information that must be processed remains within the bounds of this attentional resource pool, individuals are generally able to cope and maintain task performance. However, when the amount of information that must be processed and synthesized exceeds the resource pool's capacity, individuals may not be able to adequately handle all of the data. Ensuing performance decrement would then be expected.

One conceptualization of information processing is Shiffrin and Schneider's (1977) notion of automatic and control processing. The theory contends that individuals assimilate information through automatic or control processes. In essence, automatic processes are attention-free. They are the methods used for dealing with highly consistent, routine operations. In order for a task to be performed under an automatic processing mechanism, a large number of repetitions is usually required during skill acquisition. Control processes, on the other hand, are activated for new or unexpected operations. The control process mechanism places significant demands on the individual's attentional capacity if successful performance is to result. This distinction between automatic and control processing is important from a training perspective. Skilled individuals would be less vulnerable to attention-demanding distractions (such as stressor presence) because the attentional drain imposed would not affect the relatively attention free automatic processes. Unskilled individuals, on the other hand, would be more prone to outside influences because of their greater reliance on control processing and the resultant competition for attentional resources.

TANDEMS provides a means for examining how performance at different levels of proficiency is affected by the presence of such stressors as workload and ambiguity. During the early stages of use, when users are operating under control processes and demands on attentional resources are high, introducing stressors might be expected to contribute to performance decrement (Shiffrin & Schneider, 1977). However, when users become more highly proficient and automatic processes are operating to control performance, a stressor intervention should not have the same decremental impact as in the case of the control process mechanism since more of the attentional resource pool is available for dealing with the stressor (Fisk & Schneider, 1981). It is within this context that TANDEMS serves as a useful tool for examining performance under stress.

DEVELOPMENT RATIONALE

Interviews with fleet and training personnel, as well as observations of underway CIC teams provided the basis for the TANDEMS testbed. The types of tasks performed by team members, the ambiguity and often conflicting nature of information, and the fast-paced and dynamic environment of CIC operations were

captured and incorporated within TANDEMS. Based on a review of CIC operations, several requirements were identified for the tasks which were to be represented within TANDEMS (Department of the Navy, 1989).

First, the task had to represent accurately the cognitive and information processing demands of various positions within an actual CIC. For example, a number of different parameters are often simultaneously considered in deciding the identity of a given contact. Thus, access to multiple information parameters was a design feature that was required to be incorporated in TANDEMS in order to reflect this level of information processing (see also Zachary, Zaklad, Hicinbothom, Ryder, Purcell, & Wherry, 1991).

Second, conflicting and ambiguous data often appear on various displays within the CIC. The ambiguity may be the result of equipment degradation, unavailable data, interference, erroneous interpretation, or other factors. The operator must observe that certain information is ambiguous (or conflicts with other information), weigh that information in the context of other available data, and decide on its utility before taking an action that is based on that information. Within TANDEMS, the capability to present ambiguous and conflicting information to the user was addressed by providing a means in which certain parameters (data) accessed by the user can be made to directly conflict with other parameters.

Third, workload often varies during CIC operations (Zachary et al., 1991). At the extreme, the operator must deal with large numbers of fast-moving, potentially hostile contacts that pose serious threats. The ability to determine whether an unknown contact is friendly or hostile within this type of environment was deemed critical and therefore became a TANDEMS design requirement.

Finally, from the user's perspective, a user-friendly interface, an exercise generator, an automated performance measurement system, and a data recording facility were required for efficient system operation. TANDEMS was designed to meet all of these requirements.

TASK CHARACTERISTICS

The CIC is the "nerve center" of all surface combatants. It is the location in which sensor data are displayed and analyzed, weapon control systems are manned and operated, command and control functions are performed, and most tactical decisions are made. In short, it is the data fusion center of the ship.

The manning of a CIC is a function of both ship type (platform) and mission. Consequently, the specific pool of tasks performed may vary across platform types. Nevertheless, there are several characteristics and tasks that are common to all CICs. First, the main ingredient of the CIC is the team. It is not a group of independent individuals working in isolation, but rather it is an interdependent group working in unison toward some common goal that constitutes the essence of a CIC team.

Second, under the Navy's Composite Warfare Command (CWC) doctrine, CIC teams are partitioned into subteams who specialize in functionally different warfare areas (Department of the Navy, 1985). Although the importance of these areas varies as a function of mission, anti-air warfare, anti-surface warfare, and anti-submarine warfare areas are common to all CICs.

Third, each of the subteams is made up of individuals who must focus on both taskwork and teamwork aspects of their job in order for the team to perform optimally. Errors committed by individuals at this lowest level of the team have the potential to propagate themselves throughout the teamwork system. Consequently, performance at the individual level is crucial to ultimate team outcomes.

Finally, tactical performance is built around the premise that there are five basic functions of the CIC: detecting, tracking, identifying contacts, acting on those contacts, and performing battle damage assessment in the event of weapons release. To the extent that these functions are performed well, the CIC team is doing its job. Three of these functions - detecting, identifying, and acting - are intentionally designed into TANDEMS in order to represent the types of tasks performed in actual CIC operations.

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SYSTEM DESCRIPTION

OVERVIEW

TANDEMS represents selected functions performed by CIC personnel. It is PC-based, written in the C++ programming language, and hosted in a MS DOS environment. TANDEMS, which was developed by the Naval Training Systems Center, is configurable for team or individual operator use and can be set up for novice, apprentice, or journeymen users. System requirements include a 640x480 VGA graphics capability, a 20 megabyte hard drive, 640 kilobytes of random access memory (RAM), a Logitech 3-button trackerball with a 4.01 driver, and MS DOS version 3.3 or later. The TANDEMS software can be loaded from a 5.25" or 3.5" disk using an embedded installation program.

A sample TANDEMS screen is presented in Figure 1. On the left side of the PC monitor, the system presents radar-like contacts (blips) on a simulated radar display. The right side of the screen presents selectable on-screen menus that allow users to access information necessary to identify the contact's platform type (aircraft, ship, or submarine) and classification (friendly, unknown, or hostile). The menus are labeled A, B, and C. As the user selects one of the menus via a trackball and crosshair, textual information located within the menu is made available to the user in a series of information fields. By reviewing the contents of these information fields and comparing them to a set of decision rules, the user will be in a position to identify and label radar contacts and to take appropriate action with respect to each contact. The system is composed of three primary modules - the Exercise Generation System, the Execution (run) System, and the Performance Measurement System - each of which will be discussed below.

THE EXERCISE GENERATION SYSTEM

The Exercise Generation System provides the capability for creating scenarios on TANDEMS. Essentially, the "author" of these exercises specifies the type and number of contacts that will appear in an exercise, the difficulty of the exercise, the text strings to be used in the various information fields, and how the information fields are to be allocated to the three menus.

The author can select among six different types of contacts for the radar screen: air friendly, air hostile, surface friendly, surface hostile, submarine friendly, and submarine hostile. Once one of these six options is selected, the author then specifies the number of contacts desired. A maximum of 99 contacts can be specified across these six contact types. TANDEMS then randomly generates the specified number and type of contacts for display on the radar screen.

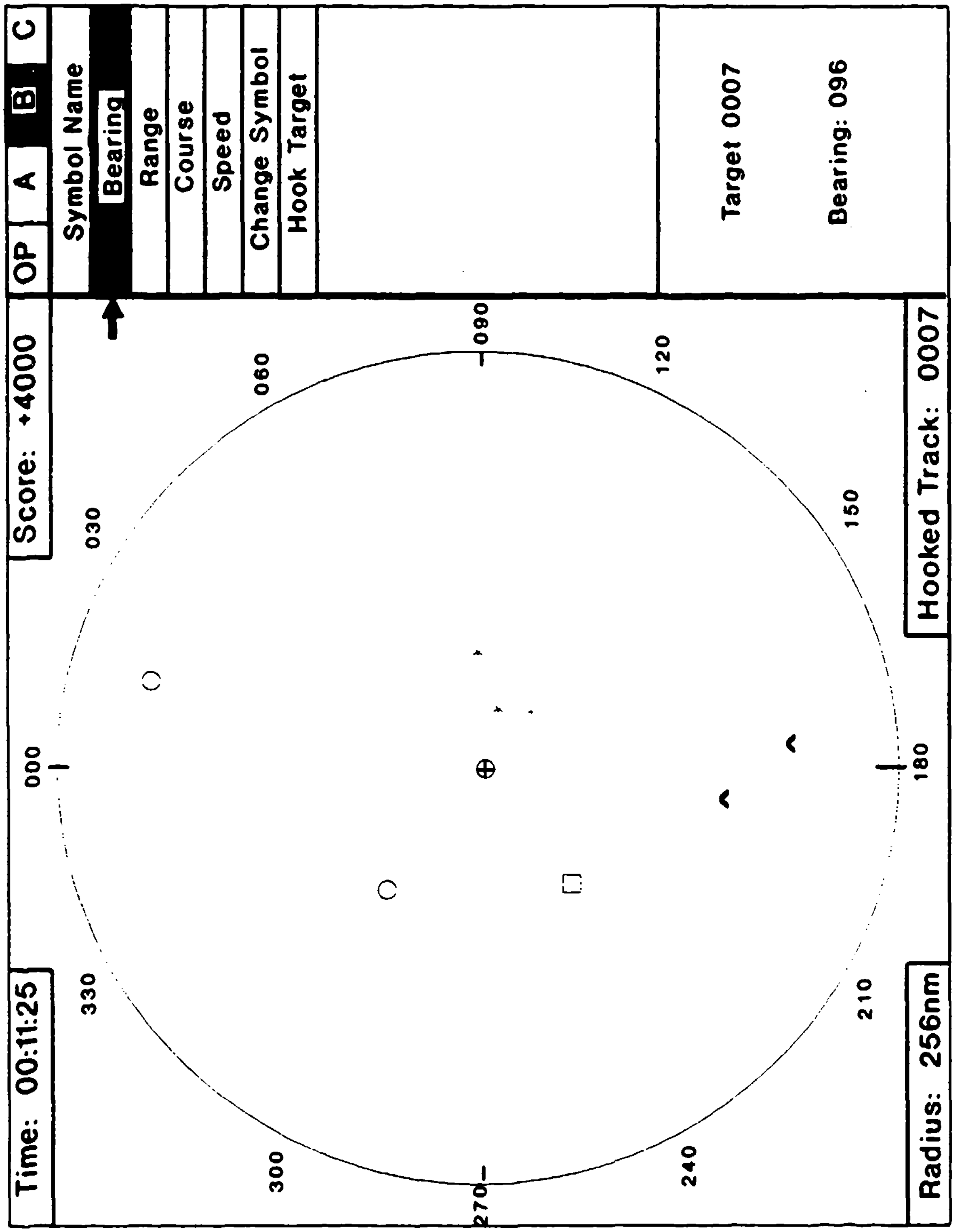

Figure 1. Sample TANDEMS screen.

During the specification process, TANDEMS also queries the author for the desired difficulty level associated with each contact type. Options include "easy," where each information field associated with a contact provides totally accurate data; "ambiguous," in which a small percentage of the data in the information fields contains inconsistent information with respect to data in other information fields; and "conflicting," whereby a larger percentage of the data in the information fields provides information in direct contrast to data in other related information fields. In all cases however, the majority of the information fields provide sufficient data to reach a correct decision.

Next, the author must select the text strings to be used in each of the information fields. This decision would be a function of user expertise, ranging from novice, through apprentice, and up to journeymen. The changes in the text strings across these levels use very simple, descriptive text for novices, progressing through more operational jargon or code words for journeymen.

Finally, the author must also allocate the various information fields to each of the three menu "slots" - designated as A, B, and C. (A fourth menu slot, labelled OP for operator, controls the exercise via start, pause, and shutdown system functions). Presently, four information fields pertain to platform type: speed, signal strength, initial altitude/depth, and initial climb/dive rate. Seven fields relate to classification: bearing, range, electronic warfare, threat level, direction of origin, countermeasures, and intelligence. Several fields contain "administrative" functions: changing range scale, changing symbols, performing final engagement, hooking contacts, and so on. As an example, the four fields related to identifying platform type might be placed in menu A, the seven fields pertaining to classification might be located in menu B, and the remaining information fields might be positioned in menu C. Up to 15 information fields can be placed in any of the three menu slots. The point is that the author is free to intermix the information fields in any configuration desired across the three menu slots.

THE EXECUTION SYSTEM

After the exercises have been generated, users run the exercises through the Execution System. An exercise is selected by name from a scrolling window of existing exercises. Once an exercise is selected, the scenario begins. Initially, all contacts are presented as non-labelled, generic "blips" of unknown platform type and classification. The user's task is to collect enough data from the information fields within each menu to determine each contact's platform type (aircraft, ship, or submarine), and classification (friendly, unknown, or hostile). Thus, there are nine different labels that can be assigned to each of the contacts (e.g., air friendly, surface hostile, etc.). To access information, the user must first "hook" (select) a contact by either using the trackball to position a crosshair on a contact and clicking the left trackball button, or by selecting a field within one of the menus. The hooked contact becomes the selected target and all information gleaned from the information fields in each menu relates specifically to that contact. The exercises are supported by a paper-based set of decision rules (see Table 1) that identify how the

Table 1

TANDEMS Decision Rules

	PLATFORM TYPE		
Information Field	AIR	SURFACE	SUBSURFACE
Speed	> 35 knots	0-35 knots	0-35 knots
Altitude/Depth	> 0 ft.	0 ft.	< 0 ft.
Climb/Dive Rate	+/-100-500'/m	0'/m	+/-100-500'/m
Signal Strength	Medium	High	Low

	CLASSIFICATION		
Information Field	FRIENDLY	UNKNOWN	HOSTILE
Initial Bearing	091-270	271-359	000-090
Initial Range	0-20nm	21-100nm	> 100nm
Countermeasures	None	Unknown	Jamming
Electronic Warfare	None	Undetected	Big Bulge Radar
Threat Level	1	2	3
Intelligence	US/Ally	Unavailable	Suspected Hostile
Dir. of Origin	Blue Lagoon	Unknown	Red Sea

information in each information field should be interpreted. The user's task, then, is to learn to tap the relevant information fields quickly and accurately, to interpret the information correctly in those fields, to label each contact in the exercise rapidly, and to perform a "final engagement" (select shoot or clear) for each contact. As such, the task is representative of functions performed in actual CICs along the dimensions of fleet practices. Specifically, users must detect contacts on the radar display, review information to identify and label contacts, and act upon each contact that appears on the display.

THE PERFORMANCE MEASUREMENT SYSTEM

The Performance Measurement System contains the data files for automatically capturing and recording user performance measures. User records are keyed by a three-digit user identification number and a two-digit designator depicting the experimental condition. Performance measures in seven areas are recorded for each user and each exercise. The performance measures that are recorded are defined below:

(1) Hook Time - This is a measure of the time from when a contact is first hooked until it is "shot" or "cleared". The time is interrupted if a new contact is hooked, and then resumed when re-hooked. It is accurate to 0.01 seconds.

(2) Click Time - The four platform type information fields and the seven classification information fields are referred to as critical information fields. They contain the information upon which decisions can be made. The information within these fields can be read only when the trackball button is depressed and held down. The time spent accessing information in these critical fields is recorded by measuring how long the trackball button is depressed when a critical field is accessed. It is recorded to the nearest 0.01 seconds.

(3) Accuracy - This measure reflects the percentage of all contacts in a given exercise that were correctly labelled and engaged.

(4) Critical Item Access - This measure indicates the number of times the user accessed any of the eleven critical information fields. Button presses less than .25 seconds are considered inadvertent clicks and are not counted in this measure.

(5) Number of Symbol Changes - Users are free to change the symbol (e.g., surface friendly) that they place on a contact as many times as desired. However, once the final engagement (shoot/clear) is executed, the contact disappears from the screen and no further action is allowed. The number of times a symbol is changed by the user before final engagement is recorded as this measure.

(6) Final Percentage Engaged - This measure is the percentage of contacts for which the user has executed a final engagement.

(7) Total Time - This measure reflects the total amount of time that has elapsed from beginning of the scenario until the last contact has been shot or cleared.

All data generated in the report generator are saved in a format amenable to data analysis.

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RESEARCH OPPORTUNITIES

TANDEMS offers many research opportunities for examining the implication of performance under varying workload and uncertainty conditions and for studying the impact of training interventions on performance. No doubt, there are many domains worthy of study within this context (see Cannon-Bowers et al., 1991). Presented below is a sample of several of these areas.

TASK VS. AMBIENT STRESSORS

TANDEMS can be readily used in a controlled laboratory environment as a test bed to support experiments on human decision-making performance. The primary focus is on the impact of various CIC-like stressors on decision making performance. For example, the impact of task-related and ambient stressors on performance as proposed by Driskell et al. (1991) provides a basis for generating testable hypotheses for this research. Task-related stressors refer to stressors inherent in the primary task that is being performed. Examples would include such variables as workload, time pressure, information ambiguity, and task difficulty. Ambient stressors, on the other hand, refer to those stressors which are not part of the primary task per se, but exist within the peripheral environment and cannot be ignored by the user. They would include variables such as auditory or visual distractions, peripheral (secondary) tasking, and evaluation apprehension (command pressure).

Within this context, a variety of research issues can be examined. For example, it would be useful to examine the differential effects of task-related and ambient stressors on task performance. To date, it is not clear if these two types of stressors influence performance in the same manner. Also useful would be a study of how stressor-induced performance affects different points in user proficiency. For example, it may be that as skills become more robust and automatic processes are governing performance, individuals may be better able to tolerate stressor presence than when skill acquisition is still occurring and control processes are operating. A related empirical issue would be whether the effects vary across user proficiency levels (e.g., novices vs. apprentices vs. journeymen).

SKILL ACQUISITION

A program of research by Friedland and Keinan (Friedland & Keinan, 1982, 1986; Keinan, 1988; Keinan & Friedland, 1984) has focused on the acquisition of skills under various techniques which couple training and stressor presence. While they have offered many suggestions on how to best configure skill acquisition with stressor presence in order to foster successful performance under stress in criterion situations, most of their research has focused on relatively simple, paper-and-pencil-based pattern recognition tasks. TANDEMS provides a mechanism for testing their findings in a context more closely aligned with military tasks.

As an example, one interesting hypothesis concerns the examination of whether the introduction of stressors during the later stages of skill acquisition will bolster later performance on subsequent criterion tests. In other words, if stressors are introduced during training at a point after the skills have been acquired, will this introduction of stressors facilitate subsequent performance in stressful situations. Relatedly, it may also be interesting to determine whether any facilitative effects of exposure to one set of stressors during training will generalize to a criterion condition in which a novel set of stressors is presented. To date, this has not been presented in the literature.

STRESS EXPOSURE TRAINING

Meichenbaum (1985) has devised a three-step, phased approach for training stress coping skills. The intent is to teach techniques for managing counter-productive effects of stress so that task performance can be maintained. Within the TADMUS program, Hall, Driskell, Salas, and Cannon-Bowers (1992) have specified design guidelines for stress exposure training. These guidelines lie in the domains of needs analysis, fidelity, sequencing, evaluation, and feedback. TANDEMS will be used as a test bed for testing and refining these guidelines as well as for testing the overall benefits of stress exposure training.

CONCLUSIONS

TANDEMS lends itself well to examining the types of empirical issues raised earlier. Although the physical fidelity of TANDEMS relative to the operational environment is low, functional fidelity is high. TANDEMS users will be presented with similar cognitive demands and information processing requirements as in an actual CIC environment. Thus, face validity and user acceptance should be high.

Because of its game-like format, the scoring component and inherent challenge should make it motivational for users. Also, exercise generation, automated performance measurement, and data recording make it an efficient facility for researchers. Data records are kept in an ASCII format for ease of use with off-the-shelf statistical analysis packages.

In summary, TANDEMS is a versatile tool for examining the performance impacts of stress. It is anticipated that the results of various experiments will shed light on how users are affected when various stressors are present, and that this, in turn, will have implications for instructional strategies aimed at ameliorating stress-produced performance decrement.

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REFERENCES

Cannon-Bowers, J.A., & Salas, E. (1990). Cognitive psychology and team training: Shared mental models in complex systems. Symposium presented at the Fifth Annual Conference of the Society for Industrial and Organizational Psychology, Miami, FL.

Cannon-Bowers, J.A., Salas, E., & Grossman, J.D. (1991, June). Improving tactical decision making under stress: Research directions and applied implications. Paper presented at the International Applied Military Psychology Symposium, Stockholm, Sweden.

Cohen, S. (1978). Environmental load and the allocation of attention. In A. Baum, J. E. Singer, & S. Valins (Eds.), Advances in environmental psychology (Vol. I, pp. 1-29). Hillsdale, NJ: Erlbaum.

Coovert, M. D., Cannon-Bowers, J.A., & Salas, E. (1990). Applying mathematical modeling technology to the study of team training and performance. In Proceedings of the 12th Interservice/Industry Training Systems Conference (pp. 326-333). Washington, DC: National Security Industrial Association.

Department of the Navy. (1985, June). Composite Warfare Commander's Manual (Naval Warfare Publication 10-1). Washington, DC: Chief of Naval Operations.

Department of the Navy. (1989, March). CG 52 class combat system doctrine (COMNAVSURFLANT Instruction C3516.39). Norfolk, VA: Naval Surface Force.

Driskell, J. E., Hughes, S. C., Guy, W., Willis, R. C., Cannon-Bowers, J. A., & Salas, E. (1991). Stress, stressors, and decision making (Contract No. DAAL03-86-D-0001). Winter Park, FL: Florida Maxima Corp.

Driskell, J. E., & Salas, E. (1991a). Group decision making under stress. Journal of Applied Psychology, 76, 473-478.

Driskell, J. E., & Salas, E. (1991b). Overcoming the effects of stress on military performance: Human factors, training, and selection strategies. In R. Gal & A.D. Mangelsdorff (Eds.), Handbook of military psychology (pp. 183-193). New York: Wiley.

Fisk, A. D., & Schneider, W. (1981). Control and automatic processing during tasks requiring sustained attention: A new approach to vigilance. Human Factors, 23, 737-750.

Friedland, N., & Keinan, G. (1982). Patterns of fidelity between training and criterion situations as determinants of performance in stressful situations. Journal of Human Stress, 8, 41-46.

Friedland, N., & Keinan, G. (1986). Stressors and tasks: How and when should stressors be introduced during training for task performance in stressful situations? Journal of Human Stress, 12, 71-76.

Glass, D. C., & Singer, J. E. (1972). Urban stress: Experiments on noise and social stressors. New York: Academic Press.

Hall, J. K., Driskell, J. E., Salas, E., & Cannon-Bowers, J. A. (1992). Development of instructional design guidelines for stress exposure training. In Proceedings of the 14th Interservice/Industry Training Systems Conference (pp. 357-363). Washington, DC: National Security Industrial Association.

Kahneman, D. (1973). Attention and effort. Englewood Cliffs, NJ: Prentice-Hall.

Kanfer, R., & Ackerman, P. L. (1989). Motivation and cognitive abilities: An integrative/aptitude-treatment interaction approach to skill acquisition. Journal of Applied Psychology, 74, 657-690.

Keinan, G. (1988). Training for dangerous task performance: The effects of expectations and feedback. Journal of Applied Social Psychology, 18, 355-373.

Keinan, G., & Friedland, N. (1984). Dilemmas concerning the training of individuals for task performance under stress. Journal of Human Stress, 10, 185-190.

Meichenbaum, D. (1985). Stress inoculation training. New York: Pergamon Press.

Shiffrin, R. M., & Schneider, W. (1977). Controlled and automatic human information processing II: Perceptual learning, automatic attending, and a general theory. Psychological Review, 84, 127-190.

Zachary, W. W., Zaklad, A. L., Hicinbothom, J. H., Ryder, J. M., Purcell, J. A., & Wherry, R. J., Jr. (1991, October). COGNET representation of tactical decision-making in ship-based anti-air warfare (NCCOSC Technical Report in Preparation). San Diego, CA: Naval Command, Control and Ocean Surveillance Center.

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